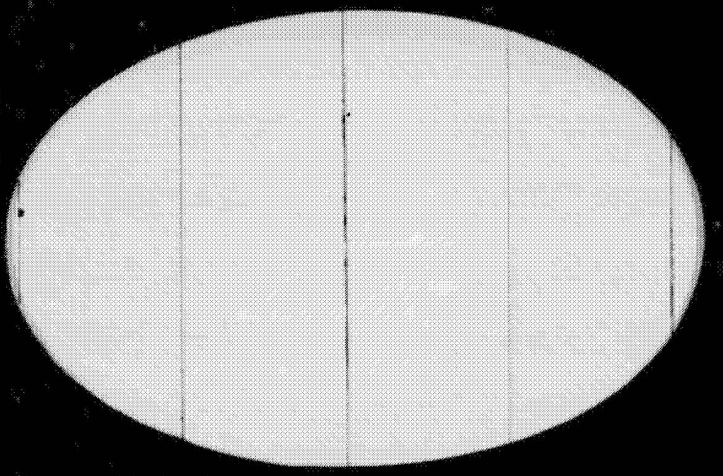

AEROTHERM
ACUREX Corporation

NASA/AMES CR-114755
Aerotherm Report No. 74-104

PHASE II, III AND IV 8 PSI PRESSURE GLOVE

by

William Elkins

AEROTHERM DIVISION/ACUREX CORPORATION

prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Contract No. NAS2-7610

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FINAL REPORT

PHASE II, III AND IV 8 PSI PRESSURE GLOVE

by

William Elkins

AEROTHERM DIVISION/ACUREX CORPORATION
485 Clyde Avenue
Mountain View, California

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

January 1975

CONTRACT NO. NAS2-7610

NASA/AMES Research Center
Moffett Field, California

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SECTION 1

INTRODUCTION

Extravehicular activities have been playing an increasing role in manned space programs. These activities allow increased overall mission efficiency and broaden the scope of mission accomplishments. In the case of Skylab, it is well known that the unscheduled EVA's turned a near mission cancellation due to catastrophic equipment failure into a highly successful series of missions.

The most critical element of the pressure suit is the glove for without outstanding mobility of the glove, trivial EVA tasks require disproportionate time and energy expenditures. These large energy and time costs tend to minimize the frequency and scope of EVA's and lead to alternative mission task solutions (i.e., automatic deployment, remote cargo handling etc.).

Space shuttle cabin pressure has been established at 14.7 psi[1] (sea level pressure). In order to eliminate the possibility of embolism during EVA's either a minimum suit pressure of 8.0 psi is required or considerable time must be expended in prebreathing pure oxygen to eliminate nitrogen in solution in the body tissues. EVA's at 4.0 psi or less are only then possible. Obviously, if there is not significant compromise of safety or mobility, an 8.0 psi suit pressure is very desirable. It was the purpose of this program described herein to prove the feasibility of a highly mobile 8.0 psi glove.

This reports presents the results of the 8.0 psi pressure glove program performed for NASA Ames under Contract NAS2-7610. The program consisted of Phase II, Phase III and Phase IV efforts which were a continuation of a Phase I (Contract NAS2-7008) effort to develop a highly mobile space suit glove capable of an 8.0 psia operational pressure. The Phase II effort was to incorporate the recommendations submitted in the Phase I final report (NASA CR-114,535), and the Phase III effort was to provide two pairs of end item 8.0 psi gloves.

This program resulted in the following developments:

1. Refinement in use of the mini-convolute construction and in finger shape to provide a better fitting more tactile arrangement.
2. A highly mobile and stable first metacarpal joint for both the palm and thumb.

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1. For metric equivalents of all pressures used in this report consult Table 1.

3. A modular construction technique which lends itself to modular production, replacement of elements and resizing of glove elements for re-use.

4. Glove elements which have demonstrated cycle life of at least 100,000 cycles for the fingers and first metacarpal joints and at least 3,000,000 cycles for the wrist joint.

The two pairs of end item 8.0 psi gloves incorporating these developments were delivered as required.

The Phase IV program implemented the recommendations made in the Phase II and III Interim Report and resulted in the following accomplishments:

1. The elimination or replacement of all hard components previously used in the Wrist joint section resulting in a "soft" convolute structure.

2. The substitution of molded urethane cable guides for the earlier metal clamp type guides used in the wrist joint, resulting in a lower profile and lower weight wrist joint which is smoother operating and exhibits a lower bending torque than previous designs.

3. The investigation and use of synthetic Kevlar cord, in lieu of braided steel cables, for restraints on the wrist joints.

4. The redesign of the first metacarpal joints of the glove for greater comfort and mobility.

One pair of 8.0 psi gloves were delivered under Phase IV program, the left hand wrist joint section restrained with Kevlar cord and the right hand wrist joint restrained with steel cable.

Section 2 of this report covers the development history of the programs. Section 3 covers recommendations for further development. Section 4 is the summary. Appendix A covers test reports.

SECTION 2

DEVELOPMENT

2.1 PHASE II

The Phase I glove (Figure 1) acted as the starting point for the Phase II prototype glove. The recommendations made in the final report for the Phase I effort, lead to major emphasis being placed in the following areas:

- Fingers
- First metacarpal joints
- Palm restraint
- Wrist joint

2.1.1 Fingers

The Phase II glove was to have more closely fitting tapered fingers than were used in the Phase I glove. A concept of integrally laying in the mini-convolutes as a single laminate structure was investigated early in the program. An integrally laid up finger was life tested successfully (Figure 2) and the first configuration of the Phase II glove used this type of finger (Figure 3).

However, difficulty in layup and large leak rates caused a revision back to the inlaid mini-convolute system similar to that used in the Phase I glove. The first configuration of the glove also had an undesirably loose fit of the fingers especially in the fingertip area.

New tooling was developed with angled and markedly tapered fingertips. The thumb and fingers were retrofitted to the Phase II glove (Figure 4) and proved to be satisfactory except for some growth in the base of the thumb and leakage in the mini-convolute inlay area.

The thumb base was reinforced and a method of pre-bonding the overlay areas of the mini-convolute border before inlaying into the basic fingers eliminated both problems in the Phase III glove.

Life test of the mini-convolute fingers to 100,000 cycles occurred in the Phase I program and was not repeated in this program.

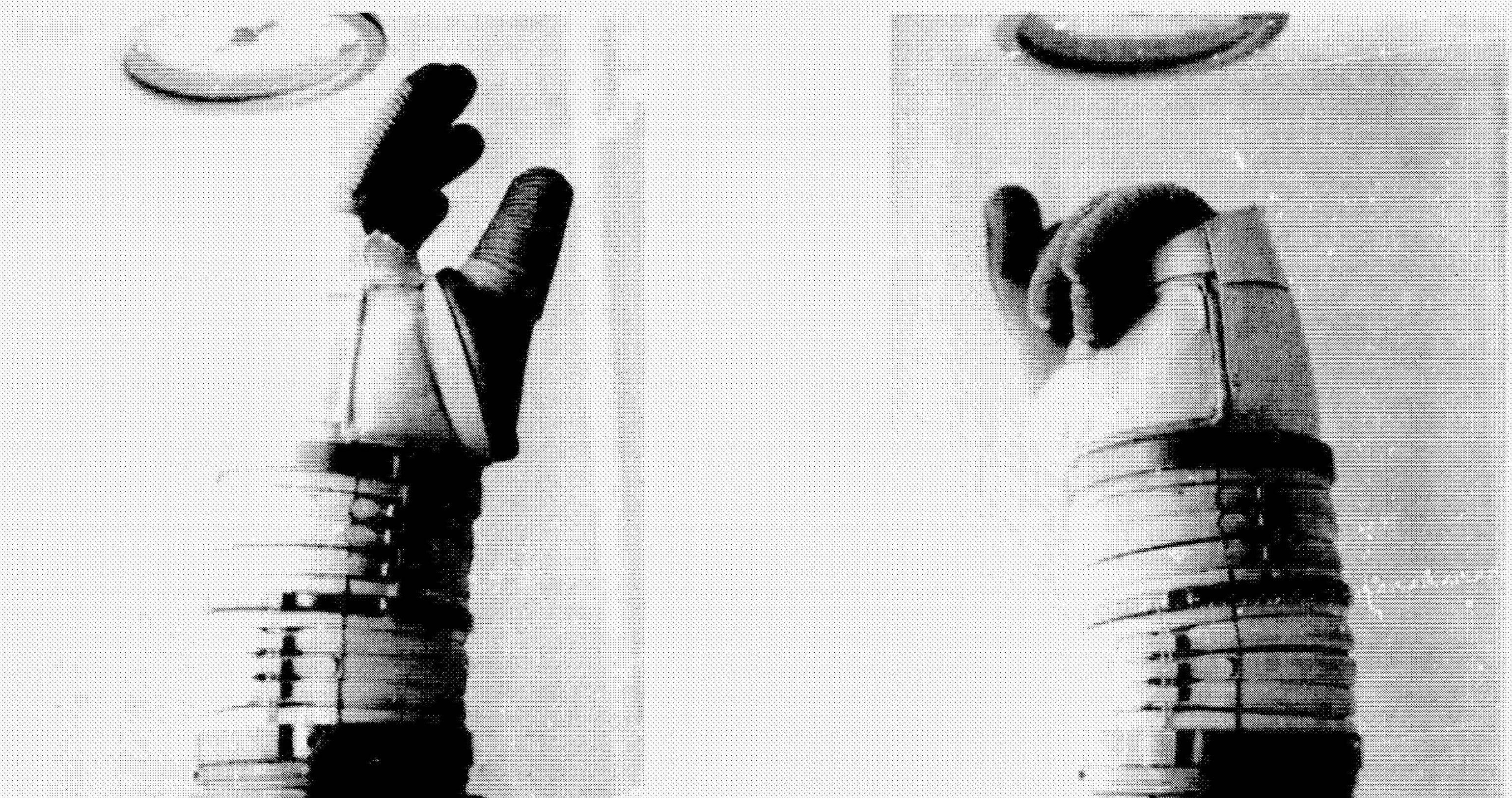

Figure 1.

8.0 psi - Phase I Glove

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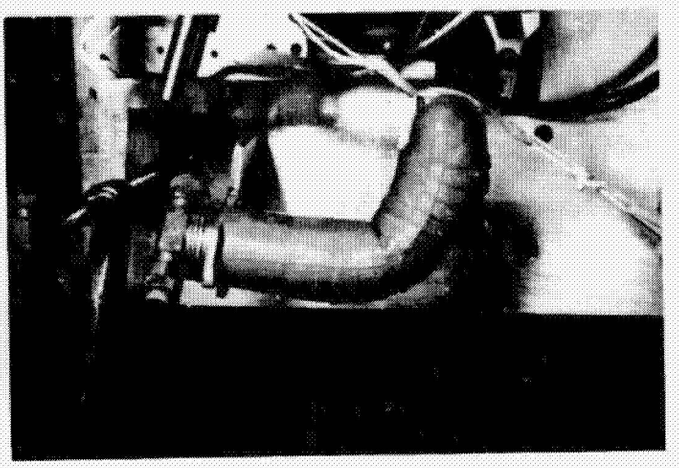


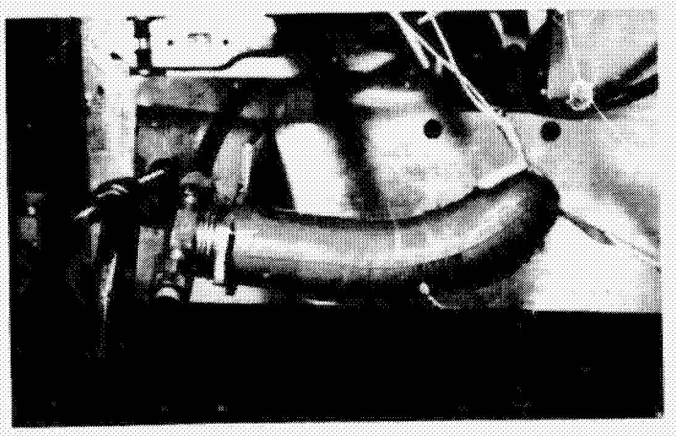


Figure 2. Finger Life Test.

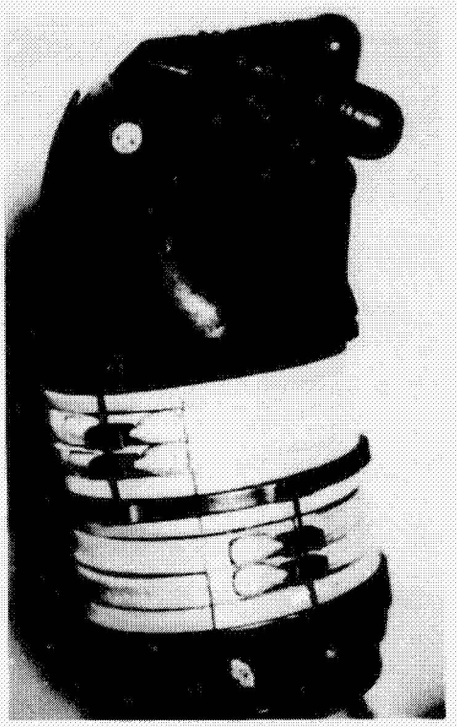


Figure 3.
Phase II Glove

Phase IIa Glove

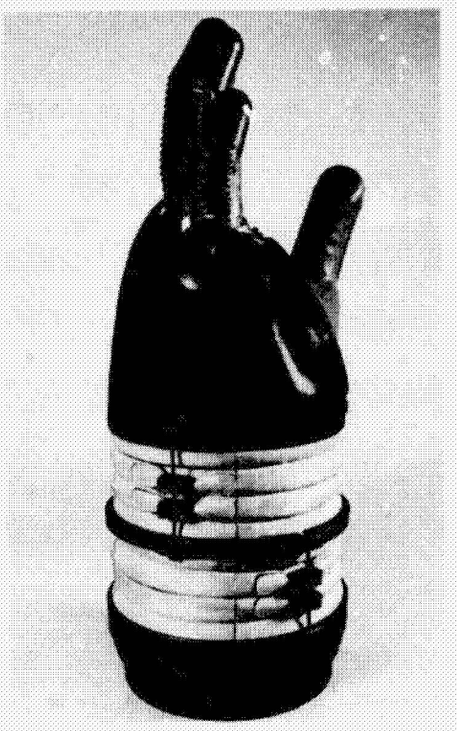


Figure 4.
Phase IIa Glove

2.1.2 First Metacarpal Joints

A rolling convolute system was developed for both the palm and thumb first metacarpal joints to replace the marginal system used in the Phase I glove. The rolling convolute joints exhibited 0.15 ft-lb (0.017 joules) torques at 8.0 psi and were passively stable.

Design changes in the Phase II glove resulted in somewhat improved clearance between the palm restraint shell and the pivot ring to which the thumb and finger caps are attached respectively. This change however, resulted in a difficult pattern development for the rolling convolute fabric and although a useful life of at least 100,000 cycles has been demonstrated for this configuration (Figure 5), subsequent gloves will use the geometry of the initial test joints because of the simple pattern development associated with those joints. The current gloves are entirely satisfactory in both life and function of these joints but ease of installation and the aesthetics of the convolute appearance can be improved.

2.1.3 Palm Restraint

A three ply epoxy reinforced fiberglass shell was used for the Phase II and III glove. Fiberglass was selected over an aluminum shell for its stiffness, safety, and thermal insulative qualities which should enhance the glove EVA configuration.

The shell integrates first metacarpal pivot bushings, which are steel inserts, and the cable restraint pick-up ring for the wrist joint. A unique scalloped effect is used at the finger first metacarpal joint to both restrain the rolling convolute fabric and allow nearly full range movement of the fingers. The scallops allow the fingers to close to a fist configuration while controlling the convolute fabric when the fingers are fully extended. The shell shape also provides clearance for the rearward movement of the dorsal aspect of the knuckles as the first metacarpal joint is flexed.

The entire shell is covered with cabretta leather and a contoured ensolite pad is bonded between the shell and the leather in the palm area to improve gripping of tools, handles, controls, etc.

In summary the glove shell provides the following integrated functions:

- Part of the first metacarpal joints including pivot bushings and convolute restraint
- Clearance area for the knuckles
- Cable pick-up for the wrist joint
- Concave area for gripping tools, controls, etc.

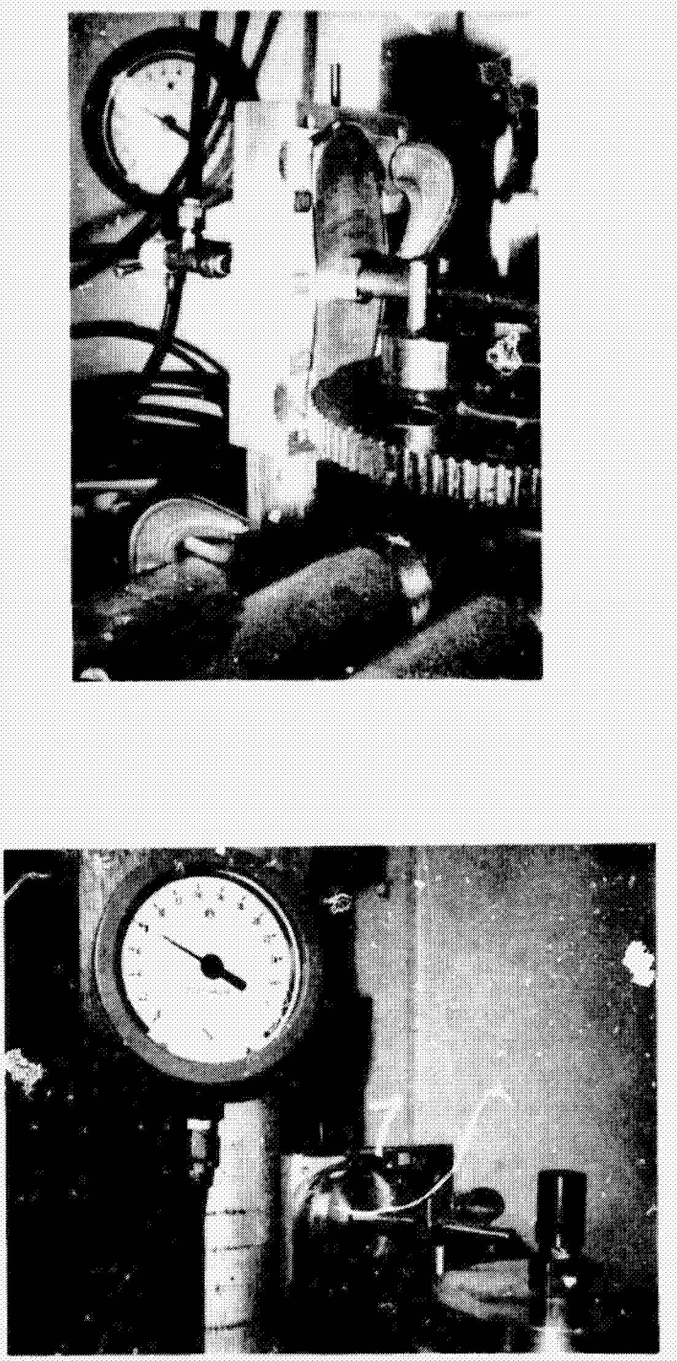


Figure 5. First Metacarpal Joints in Life Test

2.1.4 Wrist Joint

The wrist joint configuration is essentially that of the Phase I glove with the exception that one convolute per single axis element has been removed and the offset angle between cable restraint from one element to the next has been increased from 50° to 60°. The combination of these changes yields a design range of ± 60° in flexion-extension and ± 29° in adduction-abduction. In application, this range proved to be very adequate and combination of design changes between the Phase I and II gloves reduced the overall glove length by over 1.5 inches (3.81 cm). The Phase II glove is comparable in length to the A7LB gloves (Figure 6).

A single element of the wrist joint was cycle tested at 8.0 psig (Figure 7). Because the torroidal wrist joint might have application in advanced pressure suits, it was decided to life test to destruction. After the first 100,000 cycles proof pressures tests (15 psig for 15 minutes) were conducted at intervals of about every 50,000 cycles. Tests were finally terminated at 3,041,000 cycles without failure. In the process of testing the joint was subjected to 36 proof pressures which is over 9 hours of 15 psig pressure. Leak rate at termination was only 1.1 scc/min.

2.1.5 Conclusions

The outstanding reliability of the torroidal joint combined with the modularity of design in the glove elements and the extreme ruggedness of the palm area should provide a very cost effective glove system. These glove components can be used and reused for years without compromising reliability or safety.

2.2 PHASE III

The Phase III effort consisted of manufacture of two pairs of gloves essentially of the Phase II design (Figures 8 and 9). There were no major changes incorporated into the Phase III gloves. However, subtle changes and improvements were made in the fingers and first metacarpals. The performance in terms of range and torque was also measured.

2.2.1 Fingers

Reduction in the number of mini-convolutes to move the bond line away from the fingertip cone transition line was incorporated. This resulted in a more controlled convolute.

The bond area of the mini-convolutes were prepared by neoprene coating and curing. This resulted in a zero leak configuration which required no subsequent repair after installation. (Leakage occurred and repair was required on the Phase II glove.)

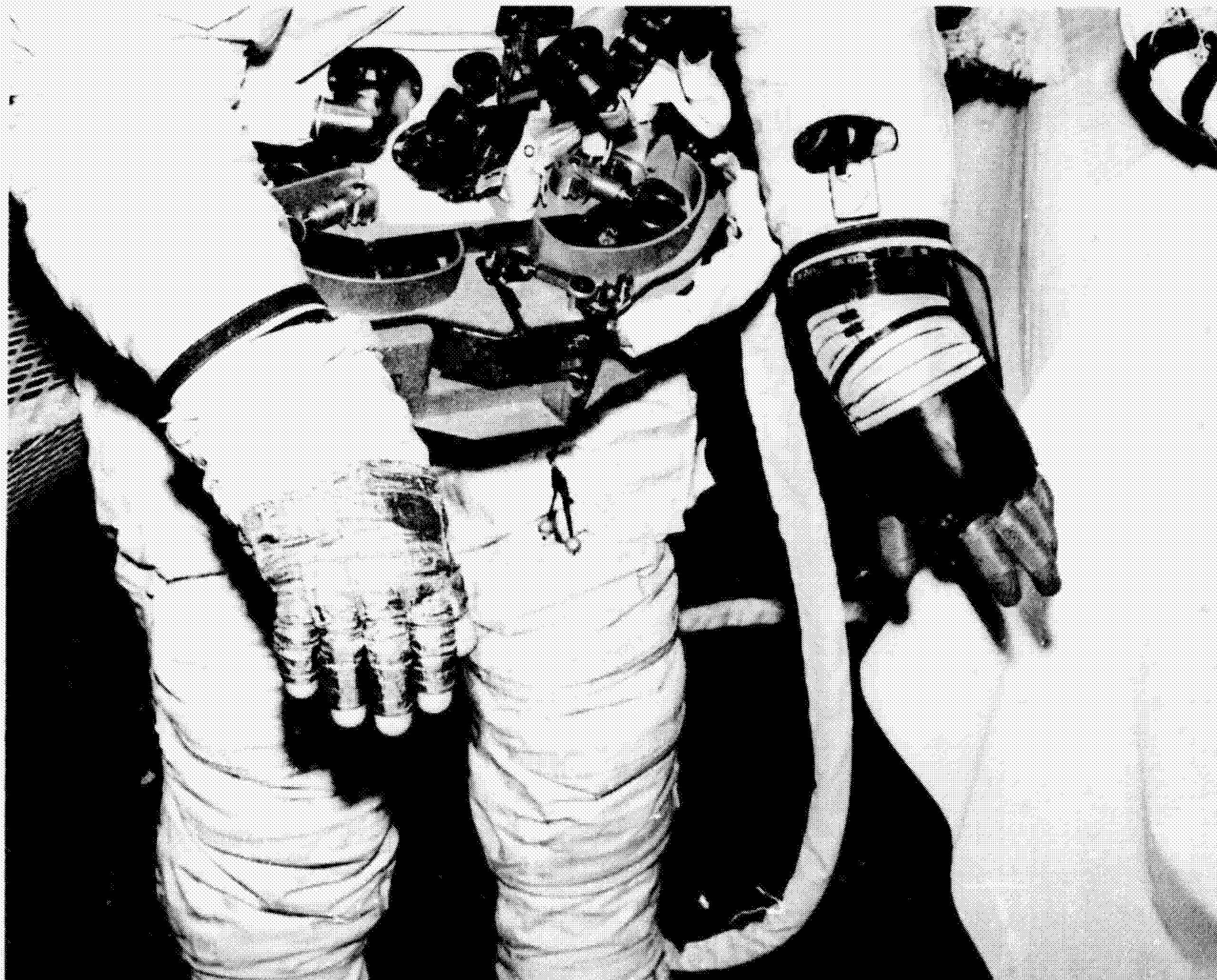


Figure 6. Phase III Glove on A7LB Skylab Suit

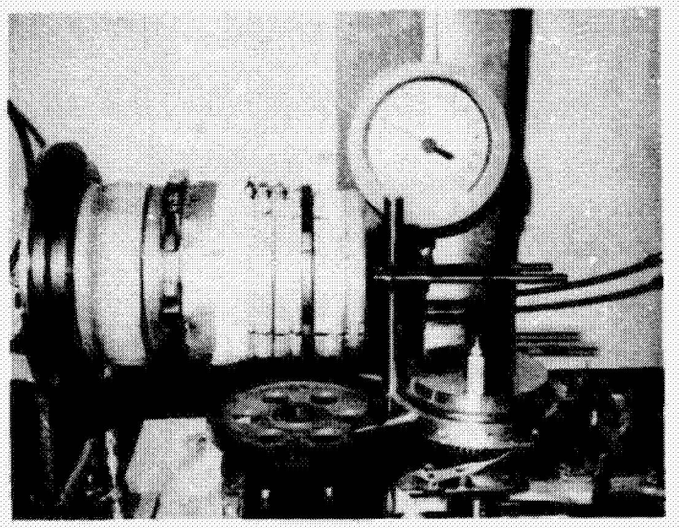


Figure 7. Wrist Joint Life Test

Figure 8. Phase III Gloves

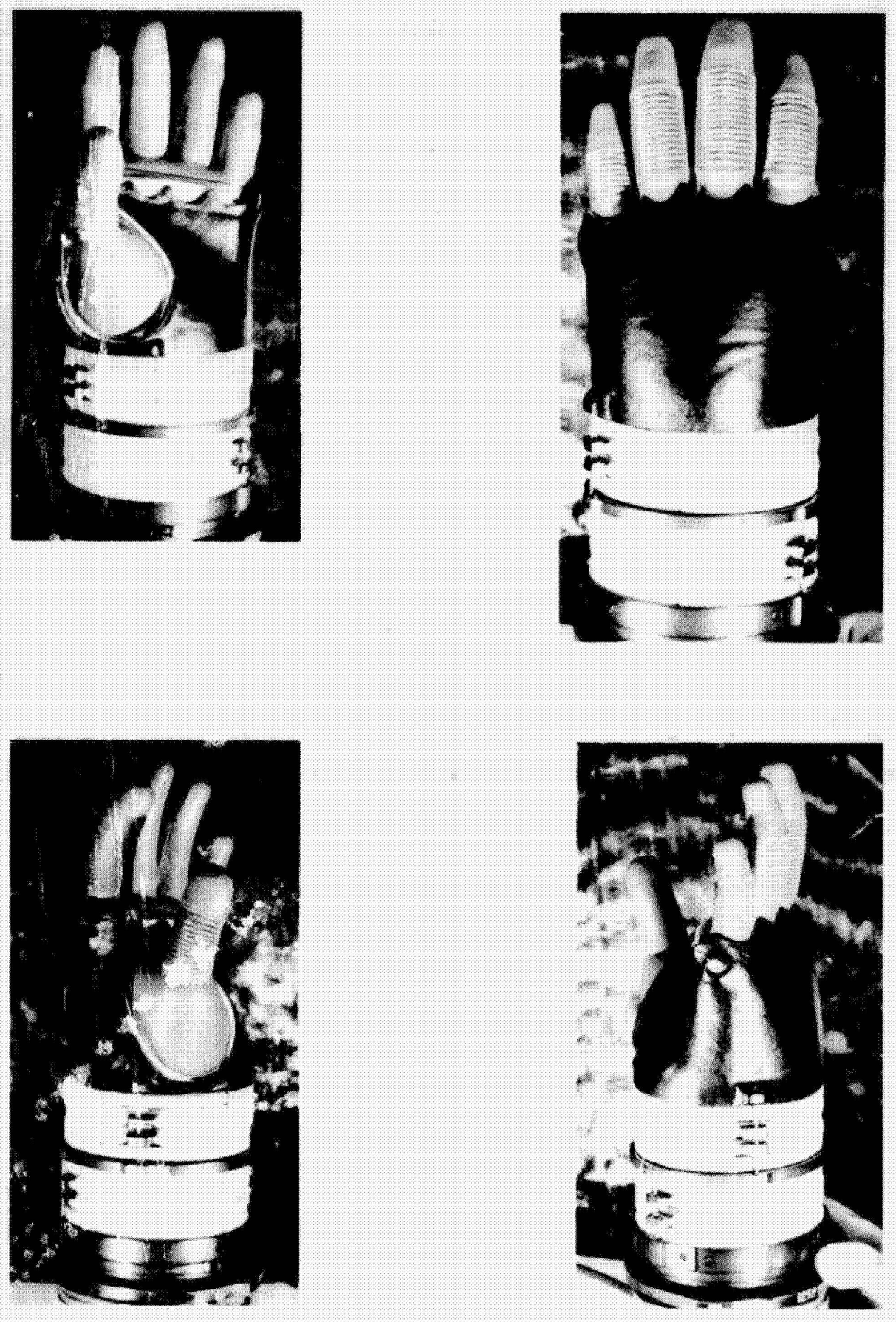


Figure 9. Four Views of Phase III Glove

The base of the thumb was reinforced to eliminate extension in the crotch of the thumb.

2.2.2 First Metacarpal Joints

Minor modification of the finger pivot ring was made. Holes which were provided for restraint lines in the Phase II glove were found to be unnecessary and were eliminated in the Phase III glove. All four Phase III gloves exhibited leak rates of under 10 scc/min at time of delivery.

2.2.3 Performance

The Phase III glove has the following ranges and torques:

Fingers - grip diameter 0.25 inches (0.635 cm)

Palm first metacarpal - Flexion extension (see Figure 10)

Range 50°

Torque 0.15 in-lb at 8.0 psig (0.017 joules at 0.55 bar)

Thumb first metacarpal - adduction-abduction (see Figure 11)

Range 47°

Torque 0.15 in-lb at 8.0 psig (0.017 joules at 0.55 bar)

Wrist Joint (see Figure 12)

Flexion-Extension

Range 60°

Adduction-Abduction

Range 29°

Torque 0.4 ft-lb at 8.0 psig (0.54 joules at 0.55 bar)

Little or no degradation in glove performance is discernable at pressures from 3.5 to 8.5 psig indicating that considerable operational pressure range can be effectively designed into future suit systems.

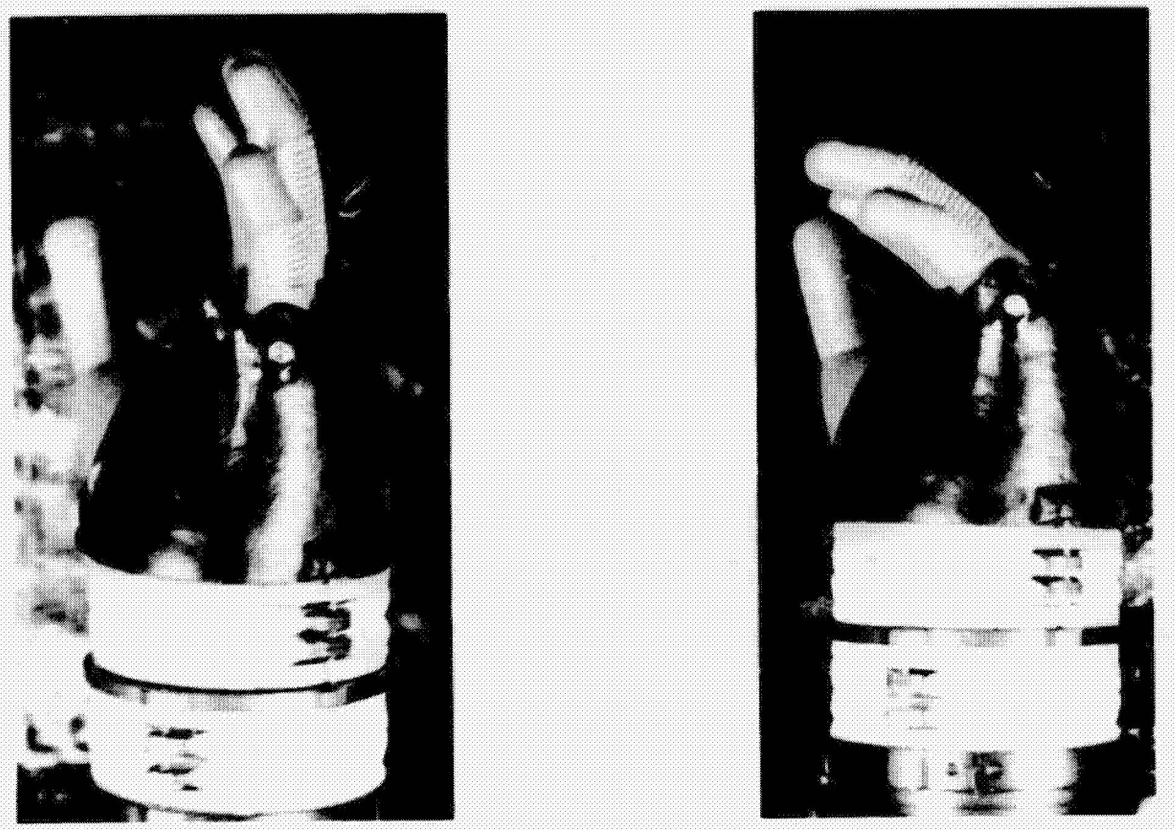


Figure 10. Palm First Metacarpal Flexion/Extension Range 50°

Figure 11. Thumb First Metacarpal Adduction/Abduction Range 47°

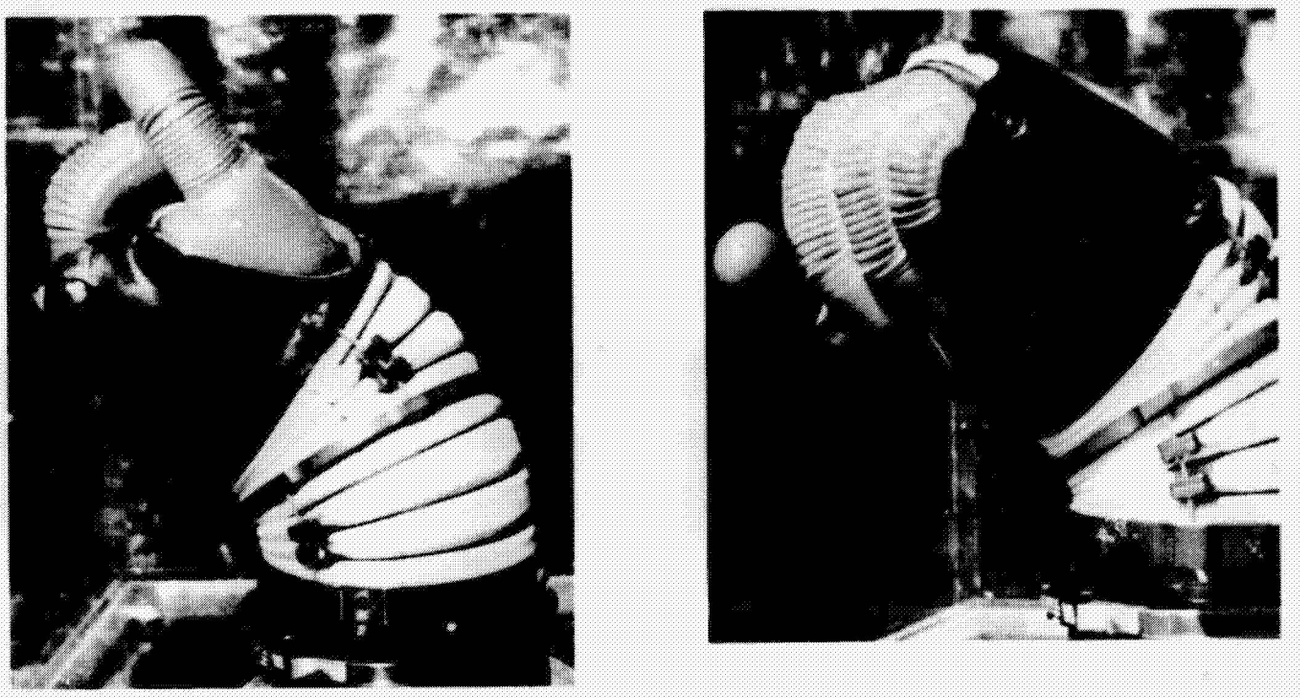


Figure 12A. Wrist Joint Flexion/Extension
Range ± 60°

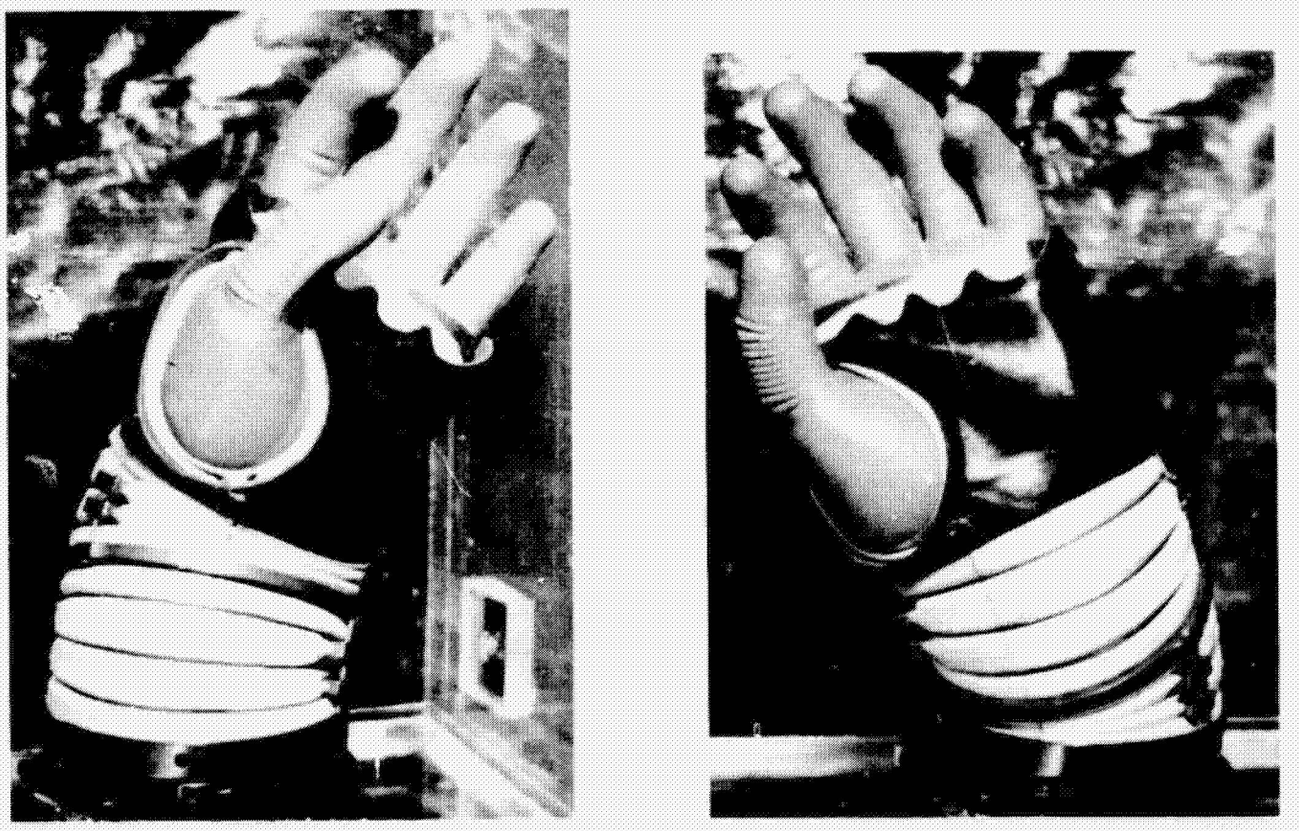


Figure 12B. Wrist Joint Adduction-Abduction
Range ± 29°

2.3 PHASE IV

The Phase IV program involved the manufacture of one pair of improved 8 psi pressure suit gloves (Figure 13) using "soft" torroidal wrist joints which were further developments of the Phase III designs. Major modifications included the substitution of Kevlar cord and tension rings for the earlier steel wire type and the elemination of all internal metal compression rings. The aluminum cable guides employed in Phase III gloves were replaced with moulded urethane parts, and on one glove the restraint cables themselves were replaced with Kevlar cord to allow evaluation of an alternative restraint material.

The hand portion of the glove was modified as a result of user evaluation of the Phase III model to incorporate improved performance in the palm and first metacarpal joints.

A 1,000,000 cycle life test was also successfully performed on both a steel cable and Kevlar cord restrained wrist joint section.

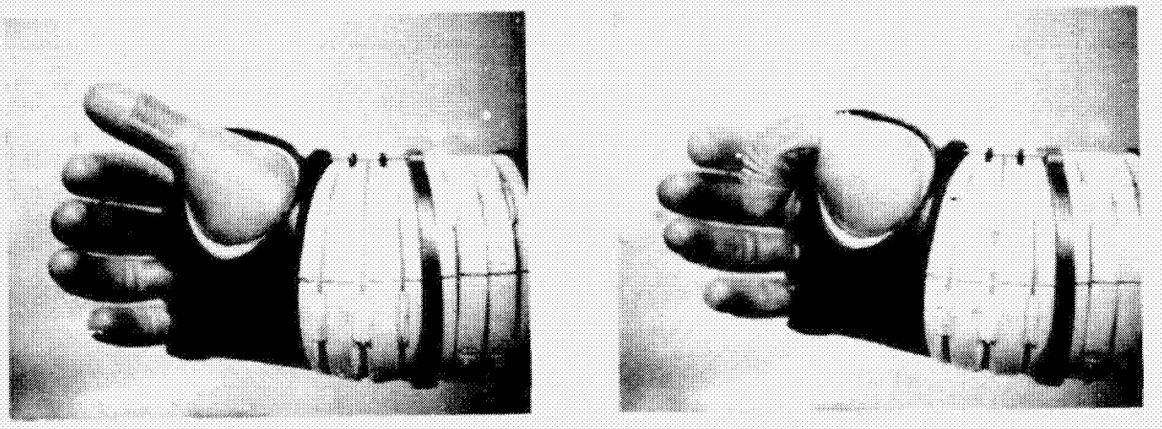
2.3.1 Soft Wrist Joints

The wrist joints of the Phase IV program were of the same general configuration as those of the Phase III effort except that they did not employ metal compression or tension rings to control the shape of the fabric convolutes during flexure. Additionally, new urethane cable guides were used on both wrists, one of which was restrained with conventional steel cable and the other which was restrained with Kevlar cord.

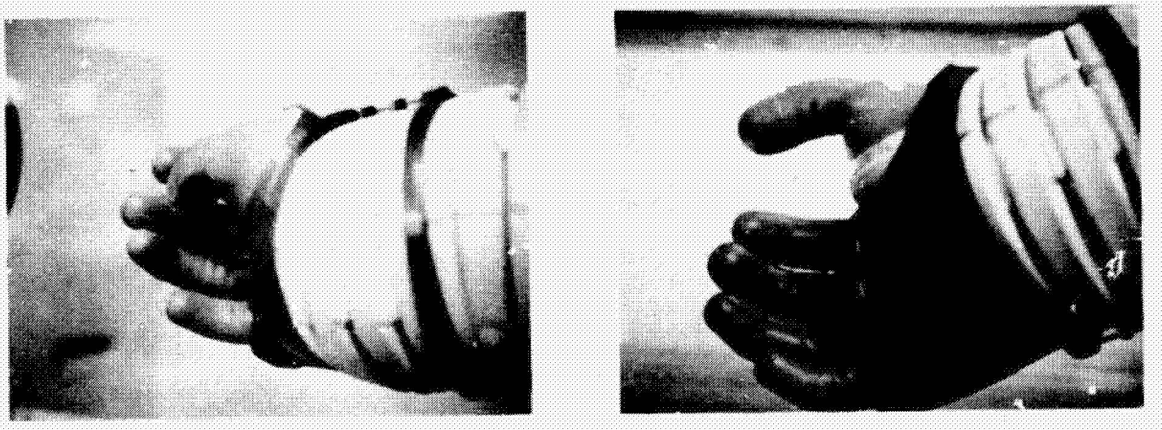
2.3.1.1 Tension/Compression Rings

Tension hoops made of stranded Kevlar fibers covered with a sheath of braided teflon and Kevlar were substituted for the steel tension rings used previously. The Kevlar core of the cord provided adequate strength to counter the hoop stresses exerted by the pressurized fabric and the teflon in the sheath functioned to facilitate the movement of the cord during flexure.

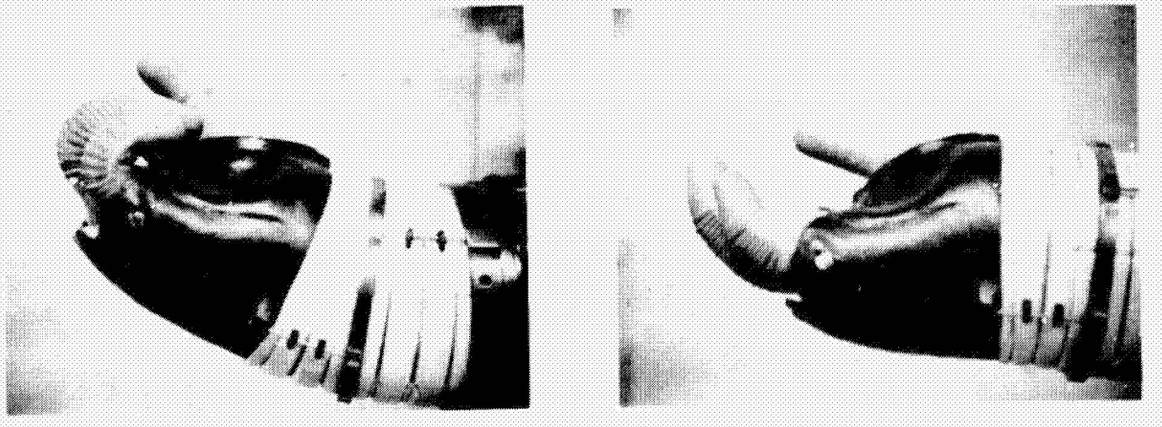
The compression rings were eliminated altogether with no noticable collapsing of the convolute stack toward the center of the joint during flexure. This "swallowing" had been observed on earlier wrist joint configurations but the degree of collapse appears to be a function of the number of convolutes that comprise an uncontrolled stack.



Thumb second and third metacarpal range 60°.



Thumb first metacarpal range 55°.



Palm and finger metacarpal range 110°.

Figure 13. Phase IV glove finger ranges.

In the Phase IV joint there are six convolutes in two groups of three, separated by a load transfer ring. The rigid transfer ring acts as an external compression ring and controls the shape of that convolute and those adjacent to it, thus preventing the convolute stack structure from collapsing toward the inside of the joint during flexure.

2.3.1.2 Cable Guides

The aluminum clamp type cable guides used in the Phase III wrist joints were replaced in the Phase IV joint elements by cable guides cast from urethane material.

The purpose of the cable guide is to control the path the cable follows along the arced convolutes of the joint during flexutre. This path should not be restricted exactly to the centerline of the joint, but rather should be slightly to one side or the other as the joint bends to compensate for the spring rate of the convolute. This results in the volume of the joint remaining relatively constant but increasing slightly as the flexure range limit is reached. This compensation contributes to low bending torques and better passive stability at deflected positions.

A slotted cable aperature was used in the Phase III gloves to provide for selective control of the cable movement but this allowed the cable free play within the slotted range and stopped all movement beyond that. The result was a slightly uneven bending movement.

A significant design improvement was realized in the Phase IV cable guides by using the elastic response of urethane materials under deflection to provide for uniform, continuous control of the degree of translation of the restraint cable from the center line of the joint throughout flexure. This was a factor in the lower, smoother bending moments experienced in the Phase IV wrist joints.

The urethane guides were bonded to the fabric of the convolutes and then reinforced with an additional over layer of fabric that covered the wide flanged base of the part. This method of securing the guide to the surface of the convolutes proved quite adequate and distributed the tangential loading imposed by the restraint cable sufficiently so that no noticable wear in the fabric was observed at the boundries of the guide after 1,000,000 test cycles.

2.3.1.3 Kevlar Restraints

Synthetic Kevlar cord was also investigated for use as an alternative to the conventional aircraft cable restraint cords used in the wrist joint. This proved to have both advantages and disadvantages associated with it.

The Kevlar material was inherently more flexible than the braided steel and thus the joints restrained with cord, as compared with the identical units using steel, showed lower bending moments. At the same time, because of its rigidity, the steel was much easier to handle during the fabrication process.

Steel cords also have a long and well proven history of being successfully terminated with great reliability and strength. The Kevlar that was used as the joint restraint in the Phase IV gloves was terminated with end fittings that were specially designed and to which only limited testing could be done. These end fittings are one area where improvements in reduced bulk, reliability and strength could be achieved with further effort although the current terminals functioned well at both normal and proof pressures over 1,000,000 cycles.

Terminating the Kevlar cord required both the bonding (using epoxy with the same coefficient of expansion as the kevlar) and swaging and was both time consuming and of questionable repeatibility. In fact the end stem gloves Kevlar terminations failed in two proof pressure tests prior to the third and successful predelivery test.

2.3.2 Metacarpal Joints

Evaluation of the Phase III gloves showed a pressure point adjacent to the the index finger at the palm's first metacarpal joint. This problem was alleviated in the Phase IV gloves by widening the glove across the first metacarpal by 1/8 inches (0.32 cm). In addition, the first metacarpal joints (both palm and thumb) were modified to cylindrical developments in lieu of the compound curvature developments used in the Phase II and III gloves.

2.3.3 Life Test

Testing of a wrist joint section, half of which was restrained with kevlar cord and half of which utilized steel cable restraints, was successfully completed for 1,000,000 cycles. Each half of the joint was tested independently for the full one million cycles with proof pressurization (15 psig) and leak rate measurements occurring every 100,000 cycles during the test.

The test apparatus is shown in Figure 14. Compressed air was used to drive the test fixture at a rate of 60 cycles per minute. The joint pressure was maintained at 8.0 psig by a regulated air supply throughout the entire test and leak rates were recorded from the unmoving joint at 8.0 psig and 15.0 psig using a calibrated Gilmont flow meter. Bending moments were measured using a spring scale and a moment arm of known length, referenced to the center of the flexed convolute section.

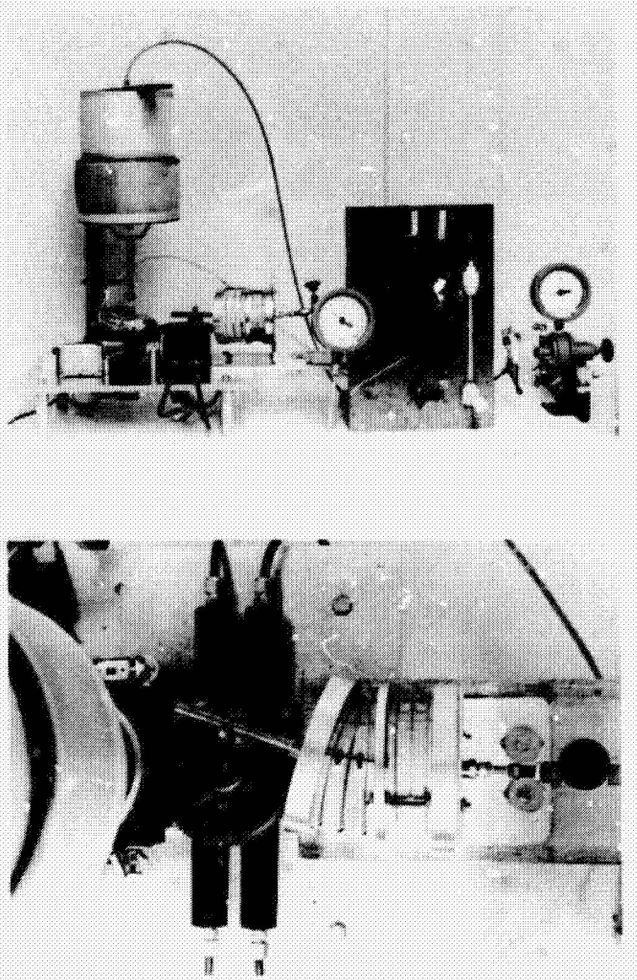


Figure 14. Wrist joint test apparatus.

The average performance figures for the two sections of the test joint over their separate 1,000,000 cycle tests are summarized below.

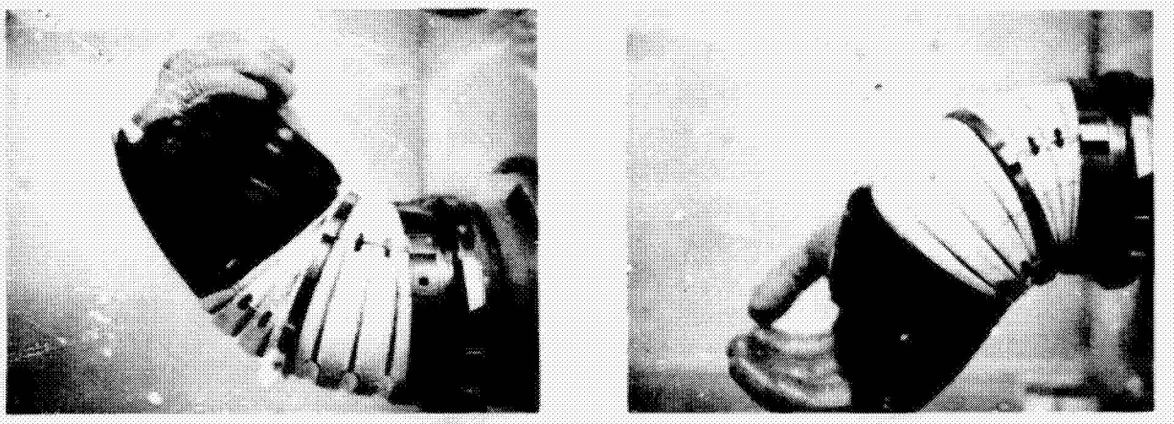
	Steel Restraint	Kevlar Restraint
Leak rate Initial	1.5 scc/min	0.0 scc/min
Leak rate Average	2.6 scc/min	0.0 scc/min
Leak rate Final	6.0 scc/min	0.0 scc/min
Bending Moment Initial	0.43 ft-lb (0.58 joules)	0.32 ft-lb (0.43 joules)
Bending Moment Average	0.30 ft-lb (0.41 joules)	0.31 ft-lb (0.42 joules)
Bending Moment Final	0.29 ft-lb (0.39 joules)	0.27 ft-lb (0.37 joules)

The higher leak rates observed during the steel cable test were caused by a small leak in the fabric of the steel side. This was patched before the start of testing but it gradually enlarged over the course of 1,000,000 cycles. Virtually all of the leakage associated with the test joint at the end of the program was from this point (as demonstrated from submersion tests) and although fabric wear was evident at several other locations, no air loss was seen from these areas in submersion tests conducted at the completion of cyclic testing.

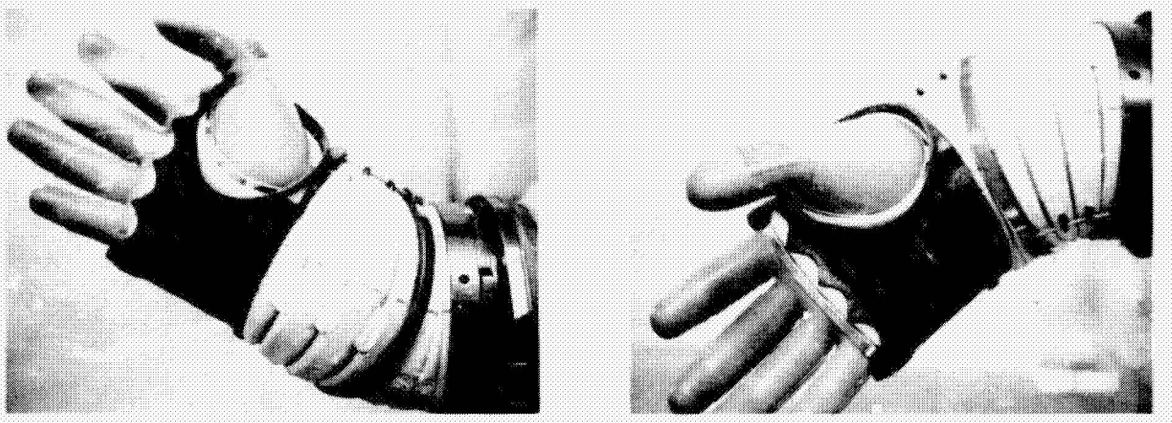
Only one design change was made during the test program. After 350,000 cycles of testing the Kevlar side of the joint, the Kevlar cord tension hoops showed evidence of recessing in diameter under the hoop stresses imposed by proof and operating pressure. Accordingly, the overlapping cemented bond was modified by increasing the overlap and sewing the ends together in addition to the use of adhesive. No slippage was experienced after this change which was also incorporated into the yet untested steel restrained side of the joint.

2.4 CONCLUSIONS

Although further effort is needed to achieve an operational EVA configuration, the Phase III and IV efforts have demonstrated the feasibility of providing highly mobile 8 psi suit components (see Figure 15). This demonstration



Flexion/Extension ± 55°.



Abduction/adduction ± 37°.

Figure 15. Wris joint ranges.

of feasibility is especially meaningful in light of the fact that gloves have traditionally been the least satisfactory suit component from both a mobility and reliability aspect.

TABLE 1. ENGLISH-METRIC PRESSURE EQUIVALENTS

PSIG	BAR
3.5	0.24
4.0	0.28
8.0	0.55
8.5	0.59
14.7	1.01
15.0	1.03

SECTION 3

RECOMMENDATIONS

The 8 psi pressure glove program has resulted in a steady series of glove improvements which clearly demonstrate feasibility of producing a highly movible and reliable 8 psi glove.

During the latter phase of the glove program, user comments have been received which indicate certain changes should be implemented in the basic glove while further development is obviously needed to configure the glove for EVA operations.

Aerotherm recommends the following efforts be accomplished in finalizing the 8.0 psi glove which are the results of user comments:

1. First Metacarpal Joints - The palm's first metacarpal joint is functioning as anticipated and will be of real value in EVA applications where grasping force is required. The thumb metacarpal is a mixture of advantageous and decrimental features. The thumb metacarpal does impose a compound contour in the glove shell and therefore reduces the useful work surface in the palmar area. The elimination of the thumb metacarpal will result in a simplified glove with lower manufacturing cost and improved grip area performance.
2. First Metacarpal Pivots - The only portions of the glove which have a noticeable increase in torque as pressure is increased are the first pivot pins and bushings. Efforts to improve the efficiency of the pivot pin bushings are recommended. Polished pivot pins running on a porous lubricated Vespel sleeve bushing would certainly reduce friction. The pivot pins are currently threaded and locked to the first metacarpal ring using Locktite adhesive. This method of securing the pivot pins may result in Locktite entering the bushing area. Methods such as roll pins, or other keeper devices should replace the current threaded connection.

3. Wrist Joint - Although both Kevlar cord and steel cable were successfully employed and tested in the Phase IV glove, the steel cable was more easily installed with a higher probability of having secure cable endings. We therefore recommend the use of steel cable in subsequent glove assembles.

4. Finger Design - The advanced pressure glove should incorporate two ply finger techniques in which an inner pressure barrier is contained by an outer restraint layer of Kevlar 49 fabric.

5. Cable Guide Improvement - The molded urethane guides are excellent both functionally and esthetically. However, alternative urethanes having a somewhat higher shore hardness and toughness should be investigated.

6. Wrist Joint Bearing - The sealed bearing torques interfere somewhat with the proper functioning of the now orthogonal wrist joint. Recent development of a low profile sealed bearing Contract NAS-2-8422 indicates that lower torques could be experienced if the new sealed bearing configuration were employed.

7. Thermal Overglove - Verification of the effectiveness of the 8.0 psi glove ultimately depends on its utility in actual or simulated EVA operations. These tests cannot realistically occur until the glove is presented in its EVA configuration. Aerotherm is currently under contract with JSC for the development of an EVA thermal glove (Contract NAS-9-14461) providing a thermal overglove for a GFE 4.0 psi glove. A parallel effort at this time to configure the 8.0 psi glove for EVA operations could be accomplished with maximum economies in its development.

SECTION 4

SUMMARY

The Phase II, III 8 psi pressure glove program has demonstrated the feasibility of providing a high pressure, very mobile and reliable glove system.

All design goals (i.e., joint range, life, torques, operational and proof pressures) were met or exceeded.

The Phase IV glove program resulted in the development of a "soft" toroidal wrist joint assembly that was lighter, lower on both profile and bending torque, but retained the same degree of durability and mobility demonstrated in the Phase III gloves. The overall design was simplified and the number of parts reduced.

Testing of a representative Kevlar and steel wrist section proved the useful lifetime of either design to be in excess of 1,000,000 cycles.

Improved comfort over the Phase III glove was accomplished by increasing finger first metacarpal dimensions.

Recommendations for continuation of this effort concern design refinement, and EVA configuration.

The significance of the success of this critical suit component is in the potential of producing an 8.0 psi space suit capable of quick reaction long term EVA's.

APPENDIX A

TEST PLANS

APPENDIX A TABLE OF CONTENTS

TEST PLAN PROCEDURE

PROGRAM: GLOVE NO. _____ DATE: June 22, , 1973

TEST NO: _____

PURPOSE: LIFE CYCLE TEST (WRIST JOINT)

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Cycle Tester	Joint press with N_2 tester cycled with shop air		
	Leak Test - 0 Cycles	8 psi/15 minutes	0.5 psi leak	
	Proof Test - 0 Cycles	15 psi/15 minutes	OK	
	Leak Test - 0 Cycles	8 psi/15 minutes	OK	
	Leak Test - 12,000 Cycles	8 psi/15 minutes	0.25 psi/15 minutes Leak	
	Leak Test - 25,000 Cycles	8 psi/15 minutes	0.25 psi/15 minutes Leak	
	Leak Test - 50,000 Cycles	8 psi/15 minutes	0.3 psi/15 minutes Leak	
	Leak Test - 50,000 Cycles	15 psi/15 minutes	0.25 psi/15 minutes Leak	
	Leak Test - 150,000 Cycles	8 psi/15 minutes	0.25/15 minutes Leak	
	Proof Test - 150,000 Cycles	15 psi/15 minutes	OK	
	Proof Test - 227,000 Cycles Leak T	15 psi/15 minutes	7.8 - 7.65 - 15 minutes, 15 change	
	Leak Test - 227,000 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 356,700 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 356,700 Cycles	15 psi/15 minutes	OK	
	Leak Test - 433,500 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 433,400 Cycles	15 psi/15 minutes	OK	
	Leak Test - 564,000 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 564,000 Cycles	15 psi/15 minutes	OK	

TEST PLAN PROCEDURE

PROGRAM: GLOVE NO. _____ DATE: July 6, 1973

TEST NO: _____

PURPOSE: LIFE CYCLE TEST (WRIST JOINT)

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1 Cont.	Leak Tests - 697,000 Cycles	8 psi/15 minutes	0.0 psi/15 minutes	
	Proof Tests - 697,000 Cycles	15 psi/15 minutes	.02 psi/15 minutes	
	Leak Tests - 697,000 Cycles	8 psi/15 minutes	No leak	
	Proof Tests - 697,000 Cycles	15 psi/15 minutes	0.2 psi/15 minutes	
	Leak Tests - 850,355 Cycles	8 psi/15 minutes	No leak	RCA
	Proof Tests - 850,355 Cycles	15 psi/15 minutes	.02 psi/15 minutes	RCA
	Leak Tests - 850,355 Cycles	8 psi/15 minutes	No leak	RCA
	Leak Tests - 878,417 Cycles	15 psi/15 minutes	.02 psi/15 minutes	
	Proof Tests - 878,417 Cycles	8 psi/15 minutes	No leak	
	Leak Tests - 926,246 Cycles	8 psi/15 minutes	No leak	
	Proof Tests - 926,246 Cycles	15 psi/15 minutes	.02 psi/15 minutes	
	Leak Tests - 926,246 Cycles	8 psi/15 minutes	No leak	
	Leak Tests - 964,047 Cycles	8 psi/15 minutes	No leak	RCA
	Proof Tests - 964,047 Cycles	15 psi/15 minutes	OK	RCA
	Leak Tests - 964,047 Cycles	8 psi/15 minutes	No leak	RCA
	Leak Test - 1,031,782 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 1,031,782 Cycles	15 psi/15 minutes	OK	
	Leak Test - 1,097,338 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 1,097,338 Cycles	15 psi/15 minutes	OK	
	Leak Test - 1,097,338 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 1,160,422 Cycles	8 psi/15 minutes	No leak	RCA
	Proof Test - 1,160,422 Cycles	15 psi/15 minutes	OK	RCA
	Leak Test - 1,160,422 Cycles	8 psi/15 minutes	No leak	RCA

TEST PLAN PROCEDURE

PROGRAM: GLOVE NO. _____ DATE: July 15, 1973

TEST NO: _____

PURPOSE: LIFE CYCLE TEST (WRIST JOINT)

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1 Cont.	Leak Test - 1,277,007 Cycles	8 psi/15 minutes	No leak (no proof taken)	
	Leak Test - 1,352,057 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 1,352,057 Cycles	15 psi/15 minutes	OK	
	Leak Test - 1,352,057 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 1,424,782 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 1,424,782 Cycles	15 psi/15 minutes	OK	
	Leak Test - 1,424,782 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 1,499,197 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 1,499,197 Cycles	15 psi/15 minutes	OK	
	Leak Test - 1,499,197 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 1,579,420 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 1,579,420 Cycles	15 psi/15 minutes	OK	
	Leak Test - 1,579,420 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 1,641,624 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 1,641,624 Cycles	15 psi/15 minutes	OK	
	Leak Test - 1,641,624 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 1,736,624 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 1,736,624 Cycles	15 psi/15 minutes	OK	
	Leak Test - 1,736,624 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 1,843,412 Cycles	8 psi/15 minutes	.01 psi/15 minutes	
	Proof Test - 1,843,412 Cycles	15 psi/15 minutes	.02 psi/15 minutes	
	Leak Test - 1,843,412 Cycles	8 psi/15 minutes	No leak	

TEST PLAN PROCEDURE

PROGRAM: GLOVE NO. _____ DATE: July 27, , 1973

TEST NO: _____

PURPOSE: LIFE CYCLE TEST (WRIST JOINT)

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1 Cont.	Leak Test - 1,919,149 Cycles	8 psi/15 minutes	.05 psi/15 minutes	
	Proof Test - 1,919,149 Cycles	15 psi/15 minutes	0.1 psi/15 minutes	
	Leak Test - 1,919,149 Cycles	8 psi/15 minutes	.05 psi/15 minutes	
	Leak Test - 1,983,346 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 1,983,346 Cycles	15 psi/15 minutes	No leak	
	Leak Test - 1,983,346 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 2,112,920 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 2, 12,920 Cycles	15 psi/15 minutes	No leak	
	Leak Test - 2,112,920 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 2,180,167 Cycles	8 psi/15 minutes	0.5 scc/minute	
	Proof Test - 2,180,167 Cycles	15 psi/15 minutes	No leak	
	Leak Test - 2,180,167 Cycles	8 psi/15 minutes	0.5 scc/minute	
	Leak Test - 2,244,346 Cycles	8 psi/15 minutes	0.5 scc/minute	
	Proof Test - 2,244,346 Cycles	15 psi/15 minutes	No leak	
	Leak Test - 2,244,346 Cycles	8 psi/15 minutes	0.5 scc/minute	
	Leak Test - 2,316,198 Cycles	8 psi/15 minutes	0.5 scc/minute	
	Proof Test - 2,316,198 Cycles	15 psi/15 minutes	No leak	
	Leak Test - 2,316,198 Cycles	8 psi/15 minutes	0.5 scc/minute	
	Leak Test - 2,378,463 Cycles	8 psi/15 minutes	0.5 scc/minute	
	Proof Test - 2,378,463 Cycles	15 psi/15 minutes	0.5 scc/minute	
	Leak Test - 2,378,463 Cycles	8 psi/15 minutes	0.5 scc/minute	
	Leak Test - 2,403,960 Cycles	8 psi/15 minutes	.05 psi/15 minutes	
	Proof Test - 2,403,960 Cycles	15 psi/15 minutes	0.4 psi/15 minutes	
	Leak Test - 2,403,960 Cycles	8 psi/15 minutes	.05 psi/15 minutes	

TEST PLAN PROCEDURE

PROGRAM: GLOVE NO. _____ DATE: August 6, 1973

TEST NO: _____

PURPOSE: LIFE CYCLE TEST (WRIST JOINT)

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1 Cont.	Leak Test - 2,506,269 Cycles	8 psi/15 minutes	0.1 psi/15 minutes	
	Proof Test - 2,506,269 Cycles	15 psi/15 minutes	0.5 psi/15 minutes	
	Leak Test - 2,506,269 Cycles	8 psi/15 minutes	0.5 scc/15 minutes	
	Leak Test - 2,639,964 Cycles	8 psi/15 minutes	0.2 psi/15 minutes	
	Proof Test - 2,639,964 Cycles	15 psi/15 minutes	OK	
	Leak Test - 2,639,964 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 2,708,653 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 2,708,653 Cycles	15 psi/15 minutes	OK	
	Leak Test - 2,708,653 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 2,768,760 Cycles	8 psi/15 minutes	1.1 cc/minute	
	Proof Test - 2,768,760 Cycles	15 psi/15 minutes	OK	
	Leak Test - 2,768,760 Cycles	8 psi/15 minutes	1.1 cc/minute	
	Leak Test - 3,040,997 Cycles	8 psi/15 minutes	1.1 cc/minute	
	Proof Test - 3,040,997 Cycles	15 psi/15 minutes	OK	

TEST PLAN PROCEDURE

PROGRAM: GLOVE NO. _____ DATE: August 23, 1973

TEST NO: _____

PURPOSE: LIFE CYCLE TEST (PALM FIRST METACARPAL)

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Leak Test - 0 Cycles	8 psi/15 minutes	No leak	
	Proof Test - 0 Cycles	15 psi/15 minutes	OK	
	Leak Test - 0 Cycles	8 psi/15 minutes	No leak	
	Leak Test - 14,577 Cycles	8 psi/15 minutes	2 ml/minute	
	Leak Test - 61,680 Cycles	8 psi/10 minutes	2 ml/minute	
	Leak Test - 80,401 Cycles	8 psi/15 minutes	2 ml/minute	
	Leak Test - 100,461 Cycles	8 psi/15 minutes	2 ml/minute	
	Proof Test - 100,461 Cycles	15 psi/15 minutes	OK	
	Leak Test - 100,461 Cycles	8 psi/15 minutes	2 ml/minute	

TEST PLAN PROCEDURE

PROGRAM: GLOVE NO. _____ DATE: August 17, 1973

TEST NO: _____

PURPOSE: LIFE CYCLE TEST (THUMB JOINT)

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Leak Test	8 psi/15 minutes	No leak	RCA
2	Proof Test	15 psi/15 minutes	OK	RCA
3	Leak Test	8 psi/15 minutes	No leak	RCA
	Leak Test	8 psi/15 minutes	No leak	RCA
	Leak Test - 19,825 Cycles	8 psi/15 minutes	No leak	RCA
	Leak Test - 63,915 Cycles	8 psi/15 minutes	No leak	RCA
	Leak Test - 87,600 Cycles	8 psi/15 minutes	No leak	RCA
	Leak Test - 102,870 Cycles Proof Test - 102,870 Cycles Leak Test - 102,870 Cycles	8 psi/15 minutes 15 psi/15 minutes 8 psi/15 minutes	No leak OK No leak	RCA RCA RCA
	Joint range tested 50° torque at start: .167 Ft-Lb, torque at completion of test:			

TEST PLAN PROCEDURE

PROGRAM: GLOVE NO. _____ DATE: August 30, 1973

TEST NO: _____

PURPOSE: LIFE CYCLE TEST (FINGER)

STEP	SET-UP	PROCEDURE	DATA	VERIFY
	Leak Test - 0 Cycles	8 psi/15 minutes	No leak	RCA
	Proof Test - 0 Cycles	15 psi/15 minutes	OK	RCA
	Leak Test - 0 Cycles	8 psi/15 minutes	No leak	RCA
	Leak Test - 18,355 Cycles	8 psi/15 minutes	No leak	RCA
	Leak Test - 45,666 Cycles	8 psi/15 minutes	No leak	RCA
	Leak Test - 81,893 Cycles	8 psi/15 minutes	No leak	RCA
	Leak Test - 101,446 Cycles	8 psi/15 minutes	No leak	RCA
	Proof Test - 101,446 Cycles	15 psi/15 minutes		
	Leak Test - 101,446 Cycles	8 psi/15 minutes	No leak	RCA

TEST PLAN-PROCEDURE

PROGRAM GLOVE PHASE II No. 7076.50 DATE February 4, 1974

TEST NO. 1

PURPOSE PRE-ACCEPTANCE TEST

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Visual Inspection	Examine glove for conformance with glove assembly drawings	Visual Inspection -	
2	Leak Rate - Use sensitive flow meter and pressure gauge, press. regulator	Pressurize glove to 8.0 ± 0.1 psig. Allow glove to stabilize at 8.0 ± 0.1 psig for 15 minutes. Take leak rate	Leak rate at 8.0 psig 50 scc/min.	AC 2
3	Proof Pressure Test Set-up Same as Above	Pressurize glove to 15 psig ± 0.1 psig for 15 minutes. Reduce pressure to 8.0 ± 0.1 psig. Allow glove to stabilize for 15 minutes. Take leak rate.	List any damage at 15 psig test. Center wrist ring distorted at 15 psi Leak rate at 8.0 psig 62 scc/min.	AC 2

TEST PLAN-PROCEDURE

PROGRAM GLOVE PHASE III No. 7076.50 DATE March 20, 1974

TEST NO. 1

PURPOSE PRE-ACCEPTANCE TEST RIGHT HAND S/N 1461

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Visual Inspection	Examine glove for conformance with glove ass'y drawings	Visual Inspection OK	CHL (AC 2)
2	Leak Rate - Use sensitive flow meter and pressure gauge, Pressure regulator	Pressurize glove to 8.0 ± 0.1 psi for 15 minutes. Take leak rate	Leak rate at 8.0 psi 4.5 scc/min 2:12 - 2:27	CHL (AC 2)
3	Proof Pressure Test	Pressurize glove to 15 psi ± C.1 for 15 minutes	List any damage None 2:57 - 3:12	CHL (AC 2)
4.	Leak Rate. Same as Above	Pressurize glove to 8.0 ± 0.1 psi for 15 minutes Take leak rate	Leak rate at 8.0 psi 1.5 scc/min	CHL (AC 2)

TEST PLAN-PROCEDURE

PROGRAM GLOVE PHASE III No. 7076.50 DATE March 20, 1974

TEST NO. 1

PURPOSE PRE-ACCEPTANCE TEST LEFT HAND S/N 1459

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Visual Inspection	Examine glove for conformance with glove ass'y drawings	Visual Inspection OK	
2	Leak rate - Use sensitive flow meter and pressure gauge, pressure regulator	Pressurize glove to 8.0 ± 0.1 psi for 15 minutes. Take leak rate	Leak rate at 8.0 psi 5.5 scc/min. 1:25 - 1:40	
3	Proof Pressure Test	Pressurize glove to 15 psi ± 0.1 for 15 minutes	List Any Damage None 1:45 - 2:00	
4	Leak Rate. Same as Above	Pressurize glove to 8.0 ± 0.1 psi for 15 minutes. Take leak rate.	Leak rate at 8.0 psi 4 scc/min. 2:10 - 9:25	

TEST PLAN-PROCEDURE

PROGRAM GLOVE PHASE III No. 7076.50 DATE February 22, 1974

TEST NO. 1

PURPOSE PRE-ACCEPTANCE TEST HAND S/N 1458

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Visual Inspection	Examine glove for conformance with glove ass'y drawings	Visual Inspection OK	OK
2	Leak Rate - Use sensitive flow meter and pressure gauge, pressure regulator	Pressurize glove to 8.0 ± 0.1 psi for 15 minutes Take leak rate	Leak rate at 8.0 psi scc/min.	N.A.
3	Proof Pressure Test	Pressurize glove to 10 psi ± 0.1 for 15 minutes	List Any Damage None	OK
4	Leak Rate. Same as Above	Pressurize glove to 8.0 ± 0.1 psi for 15 minutes Take leak rate	Leak rate at 8.0 psi 3 scc/min.	OK

TEST PLAN-PROCEDURE

PROGRAM GLOVE PHASE III No. 7076.50 DATE February 23, 1974

TEST NO. 1

PURPOSE PRE-ACCEPTANCE TEST LEFT HAND S/N 1458

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Visual Inspection	Examine glove for conformance with glove ass'y drawings	Visual Inspection OK	WE
2	Leak Rate - Use sensitive flow meter and pressure gauge, pressure regulator	Pressurize glove to 8.0 ± 0.1 psi for 15 minutes Take leak rate	Leak rate at 8.0 psi 5 scc/min 10:30 - 10:45	WE
3	Proof Pressure Test	Pressurize glove to 15 psi ± 0.1 for 15 minutes	List any damage None 10:48 - 11:03	WE
4	Leak Rate. Same as Above	Pressurize glove to 8.0 ± 0.1 psi for 15 minutes Take leak rate	Leak Rate at 8.0 psi > 2 scc/min 11:03 - 11:18	WE

TEST PLAN-PROCEDURE

PROGRAM GLOVE PHASE III No. 7076.50 DATE February 22, 1974

TEST NO. 1

PURPOSE PRE-ACCEPTANCE TEST HAND S/N 1460

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Visual Inspection	Examine glove for conformance with glove ass'y drawings	Visual Inspection	OKL (AC 2)
2.	Leak Rate - Use sensitive flow meter and pressure gauge, pressure regulator	Pressurize glove to 8.0 ± 0.1 psi for 15 minutes Take leak rate	Leak rate at 8.0 psi scc/min.	N.A.
3	Proof Pressure Test	Pressurize glove to 10 psi ± 0.1 for 5 minutes	List Any Damage None	OKL (AC 2)
4	Leak Rate. Same as Above	Pressurize glove to 8.0 ± 0.1 psi for 15 minutes Take leak rate	Leak rate at 8.0 psi 70 scc/min. Leak was due to bad seal in airlock connector and not a fault of glove	OKL (AC 2)

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-6-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Uncycled Kevlar section Leak rate ≅ 0.0 scc/min Bending force (avg.) = 11.2 oz	JF
2	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	Leak rate ≅ 0.0 scc/min	JF
3	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 11.0 oz	JF
4	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig, 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-7-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	72,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 10.5 oz	JT
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate ≅ 0.0 scc/min	JT
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 10.5 oz	JT
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-9-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	175,350 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 10.5 oz	JF
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate ≅ 0.0 scc/min	JF
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 11.0 oz	JF
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-11-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	292,500 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 0.5 scc/min Bending force (avg.) =10.5 oz	JF
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 1.5 scc/min	JF
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 0.5 scc/min Bending force (avg.) = 10.0 oz	JF
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-12-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	335,400 cycles Tension hoop recessing in diameter, sewn bond integrated for evaluation on all hoop cords. Patch leak in untested steel side of joint.	JT
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate - 0.0 scc/min Bending force (avg.) = 11 oz	JT
3	Wrist joint and cycle apparatus	Cycle test wrist section for remainder of 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-16-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	391,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 12.0 oz	JT
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate ≅ 0.0 scc/min	JT
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 12.0 oz	JT
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-17-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	491,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 12.2 oz	JF
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate ≅ 0.0 scc/min	JF
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 11.0 oz	JF
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

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TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-19-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	594,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 12.0 oz	JT
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate ≅ 0.0 scc/min	JT
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 11.5 oz	JT
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-21-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	692,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 11.0 oz	JT
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate ≅ 0.0 scc/min	JT
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 10.5 oz	JT
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-22-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	797,500 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 10.0 oz	JF
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate ≅ 0.0 scc/min	JF
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 10.0 oz	JF
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-24-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	910,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) =10.0 oz	JF
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate ≅ 0.0 scc/min	JF
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 9.5 oz	JF
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-25-74

TEST NO. 7076-01 NAME J. Fletcher

PURPOSE Life Test of Kevlar Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	1,000,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 100 oz	JT
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate ≅ 0.0 scc/min	JT
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate ≅ 0.0 scc/min Bending force (avg.) = 9.5 oz	JT
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-25-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Uncycled steel section Leak rate = 0.5 scc/min Bending force (avg.) = 16 oz	JT
2	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	Leak rate = 0.5 scc/min	JT
3	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 0.5 scc/min Bending force (avg.) = 18 oz	JT
4	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig, 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 11-28-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle apparatus	Allow failure of steel restraints. Record leak rate at 8 psig	51,680 cycles, first cable fails 82,550 cycles, second cable fails Leak rate - 0.5 scc/min	JT JT
2	Wrist joint	Fit modified cable guides to test joint	New cable guides installed on steel side only	JT
3	Wrist joint and cycle apparatus	Restart life test of steel cable wrist section at zero cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-3-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check ar record bending force at 8 .	Restart of steel section test Leak rate = 1.5 scc/min Bending force (avg.) = 15 oz	JT
2	Pressure supply and leak meter	Proof pressure .5 psig for 15 min. Leak check at 15 psig	Leak rate = 2.0 scc/min	JT
3	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 1.5 scc/min Bending force (avg.) = 11. oz	JT
4	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig, 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-5-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	113,500 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.5 scc/min Bending force (avg.) = 11.5 oz	JT
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 4.0 scc/min	JT
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.5 scc/min Bending force (avg.) = 10 oz	JT
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

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TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-7-74

TEST NO. 7076-02 NAME W. Elkins

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	193,801 cycles	WE
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.0 scc/min Bending force (avg.) = 8.0 oz	WE
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 5.0 scc/min	WE
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.0 scc/min Bending force (avg.) = 9.0 oz	WE
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-8-74

TEST NO. 7076-02 NAME W. Elkins

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	282,000 cycles	W.E
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 3.0 scc/min Bending force (avg.) = 10 oz	W.E
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 5.0 scc/min	W.E
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.0 scc/min Bending force (avg.) = 10 oz	W.E
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-9-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	403,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.0 scc/min Bending force (avg.) = 9.5 oz	JF
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 4.2 scc/min	JF
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.6 scc/min Bending force (avg.) = 9.5 oz	JF
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-10-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	493,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.5 scc/min Bending force (avg.) = 9.5 oz	JT
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 4.0 scc/min	JT
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.5 scc/min Bending force (avg.) = 9.0 oz	JT
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-12-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle apparatus	Stop cycle test of wrist section	604,600 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.5 scc/min Bending force (avg.) = 9.5 oz	JT
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 4.2 scc/min	JT
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.5 scc/min Bending force (avg.) = 9.5 oz	JT
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-14-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	704,600 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.0 scc/min Bending force (avg.) = 9.5 oz	JF
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 4.2 scc/min	JF
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.0 scc/min Bending force (avg.) = 8.5 oz	JF
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-17-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	800,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.0 scc/min Bending force (avg.) = 10.0 oz	JF
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 4.2 scc/min	JF
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 2.0 scc/min Bending force (avg.) = 9.5 oz	JF
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-20-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	892,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 3.0 scc/min Bending force (avg.) = 10.0 oz	JT
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 9.0 scc/min	JT
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 3.0 scc/min Bending force (avg.) = 9.5 oz	JT
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 12-23-74

TEST NO. 7076-02 NAME J. Fletcher

PURPOSE Life Test of Steel Restrained Wrist Section

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Wrist joint and cycle and apparatus	Stop cycle test of wrist section	1,035,000 cycles	
2	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 6.0 scc/min Bending force (avg.) = 9.5 oz	JT
3	Pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 17.2 scc/min	JT
4	Wrist joint, leak meter, 5.5" moment arm and spring scale	Leak check and record bending force at 8 psig	Leak rate = 6.0 scc/min Bending force (avg.) = 9.5 oz	JT
5.	Wrist joint and cycle apparatus	Cycle test wrist section at 8 psig 100,000 cycles		

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 1-18-75

TEST NO. 7076-03 NAME J. Fletcher

PURPOSE Predelivery Leak and Proof Test - Right Glove

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Right glove, pressure supply and leak meter	Leak check at 8 psig	Leak rate = 6.0 scc/min	JT
2	Right glove, pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	No evidence of failure Leak rate = 8.0 scc/min	JT
3	Right glove, pressure supply and leak meter	Leak check at 8 psig	Leak rate = 6.0 sec/min	JT

TEST PLAN-PROCEDURE

PROGRAM PHASE IV GLOVE NO. 7076.82 DATE 1-18-75

TEST NO. 7076-03 NAME J. Fletcher

PURPOSE Predelivery Leak and Proof Test - Left Glove

STEP	SET-UP	PROCEDURE	DATA	VERIFY
1	Left glove, pressure supply and leak meter	Leak check at 8 psig	Leak rate = 5.2 scc/min	JF
2	Left glove, pressure supply and leak meter	Proof pressure 15 psig for 15 min. Leak check at 15 psig	Terminal failures at 15 psig after 24 seconds and at 14 psig before successful test Leak rate = 8.0 sec/min	JF
3	Left glove, pressure supply and leak meter	Leak check at 8 psig	Leak rate = 5.2 scc/min	JF